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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/049,971	02/12/2002	Satoshi Komiya	86396	8978

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	PAPER NUMBER
1765	7

DATE MAILED: 07/03/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/049,971	Applicant(s) KOMIYA ET AL.	
	Examin r Matthew J Song	Art Unit 1765	

-- *The MAILING DATE of this communication appears on the cover sheet with the correspondence address* --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 April 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-7* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-7* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1-3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Wijarankula (US 5,961,713) in view of Graef et al (US 5,935,320) or Tamatsuka et al (US 6,162,708).

Wijarankula discloses a silicon substrate **12** with a diameter of approximately 200 mm and includes a boron dopant of $3x10^{18}$ atoms/cm3 and approximately 23 ppma oxygen. Wijarankula also discloses using semiconductor silicon substrates and epitaxial layers having wide ranges of thicknesses, dopants and dopant concentrations (col 4, ln 10-43). Wijarankula also discloses a typical microdefect **14** with a diameter greater than 0.1 micrometer (100 nm), this reads on applicant's LPDs, and growing a single crystal by the Czochralski method and slicing an ingot into semiconductor silicon wafers (col 4, ln 44-67). Wijarankula also discloses a process step **46** for depositing an epitaxial layer, where the epitaxial layer forms a microdefect-free layer **16** and the concentration of microdefects **14** decreases over a finite transition region **30** from a relatively high concentration in the substrate bulk to approximately zero (col 5, ln 1-67, col 6, ln 1-40 and Figs 2-3).

Wijarankula does not disclose a substrate doped with nitrogen.

In a process for forming silicon semiconductor wafers, note entire reference, Graef et al teaches preparing a silicon single crystal having an oxygen concentration of at least $4x10^{17}/cm^3$ and a nitrogen doping concentration of at least $1x10^{14}/cm^3$ and processing the silicon single crystal to form silicon wafers with a low defect density (col 2, ln 40-67). Graef et al also teaches the proportion of large defects decreases greatly with the increase in the degree of nitrogen doping (col 6, ln 10-20 and Example 2). Graef et al also teaches the effect of doping the single crystal with nitrogen in terms of defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping, the proportion of small defects increases as the oxygen doping decreases (col 3, ln 40-45). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wijarankula with Graef et al's nitrogen doped silicon substrate to reduce larger defects in the silicon substrate wafer.

In a process for forming an epitaxial silicon wafer, note entire reference, Tamatsuka et al teaches an epitaxial silicon single wafer characterized in that a silicon single crystal ingot which nitrogen is doped is grown by the Czochralski method and the resultant silicon single crystal ingot is sliced to produce a silicon single crystal wafer and then a epitaxial layer is formed in the surface layer portion of the resultant silicon single crystal wafer (col 2, ln 1-15). Tamatsuka et al also teaches when the nitrogen concentration of the silicon single crystal wafer is $1x10^{13}$ to $1x10^{14}$ atoms/cm3, it is possible to decrease the defect density on the surface of the epitaxial layer (col 4, ln 1-67). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wijarankula with Tamatsuka's nitrogen doped silicon wafer to decrease the defect density on the surface of an epitaxial layer.

The combination of Wijarankula and Graef et al or the combination of Wijarankula and Tamatsuka et al does not teach the range of nitrogen concentration and oxygen concentration falls within an area in a graph in which the oxygen and nitrogen concentrations are plotted along the horizontal axis and vertical axis of the graph, respectively, on or below a straight line connecting a point at which the nitrogen concentration is $3x10^{15}$ atoms/cm^3 when the oxygen concentration is $7x10^{17}$ atoms/cm^3 and a point at which the nitrogen concentration is $3x10^{14}$ atoms/cm^3 when the oxygen concentration is $1.6x10^{18}$ atoms/cm3. Graef et al teaches the effect of doping the single crystal with nitrogen in terms of defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping, the proportion of small defects increases as the oxygen doping decreases (col 3, ln 40-45), this is a teaching that the relationship between the oxygen and nitrogen doping concentration is a result effective variable. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Wijarankula and Graef et al or the combination of Wijarankula and Tamatsuka et al by optimizing the nitrogen and oxygen concentration to obtain same by conducting routine experimentation of result effective variables to minimize large defects. Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claim 2-3, Wijarankula teaches a microdefect size of greater than 0.1 micrometer (100 nm) or greater with a density of approximately zero for a 200 mm wafer. Overlapping ranges are held to be obvious (MPEP 2144.05).

3. Claims 4-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Graef et al (US 5,935,320).

Graef et al teaches preparing a silicon single crystal having an oxygen concentration of at least $4x10^{17}/cm^3$ and a nitrogen doping concentration of at least $1x10^{14}/cm^3$ and processing the silicon single crystal to form silicon wafers with a low defect density (col 2, ln 1-67). Graef et al also teaches the proportion of large defects decreases greatly with the increase in the degree of nitrogen doping (col 6, ln 10-20 and Example 2). Graef et al also teaches test have shown that the effect of doping the single crystal with nitrogen in terms of the defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping, the proportion of small defects increases as the oxygen doping decreases (col 3, ln 15-45). Graef et al also teaches the single crystal is produced by the Czochralski method (col 3, ln 45-67).

Graef et al does not teach the range of nitrogen concentration and oxygen concentration falls within an area in a graph in which the oxygen and nitrogen concentrations are plotted along the horizontal axis and vertical axis of the graph, respectively, on or below a straight line connecting a point at which the nitrogen concentration is $3x10^{15}$ atoms/cm^3 when the oxygen concentration is $7x10^{17}$ atoms/cm^3 and a point at which the nitrogen concentration is $3x10^{14}$ atoms/cm^3 when the oxygen concentration is $1.6x10^{18}$ atoms/cm3. Graef et al teaches the effect of doping the single crystal with nitrogen in terms of defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping, the proportion of small defects increases as the oxygen doping decreases (col 3, ln 40-45), this is a teaching that the relationship between the oxygen and nitrogen doping

concentration is a result effective variable. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Graef et al by optimizing the nitrogen and oxygen concentration to obtain same by conducting routine experimentation of result effective variables to minimize large defects. Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claim 5, Graef et al does not teach the oxygen concentration is lowered corresponding to and in accordance with an increase in nitrogen concentration. Graef et al teaches doping the single crystal with nitrogen in terms of the defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Graef et al by optimizing the oxygen concentration in relation to the nitrogen concentration to obtain same by conducting routine experimentation of result effective variables because a connection with the oxygen concentration to the nitrogen concentration is known.

4. Claims 4-7 are rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al (US 6,162,708).

Tamatsuka et al teaches an epitaxial silicon single wafer characterized in that a silicon single crystal ingot which nitrogen is doped to a concentration of $1x10^{10}$ to $5x10^{15}$ atoms/cm^3 is grown by the Czochralski method and the resultant silicon single crystal ingot is sliced to

produce a silicon single crystal wafer (col 2, ln 1-67). Tamatsuka et al also teaches the oxygen concentration is 18 ppma ($9x10^{17}$ atoms/cm3) or less (col 4, ln 1-25).

Tamatsuka et al does not teach the range of nitrogen concentration and oxygen concentration falls within an area in a graph in which the oxygen and nitrogen concentrations are plotted along the horizontal axis and vertical axis of the graph, respectively, on or below a straight line connecting a point at which the nitrogen concentration is $3x10^{15}$ atoms/cm^3 when the oxygen concentration is $7x10^{17}$ atoms/cm^3 and a point at which the nitrogen concentration is $3x10^{14}$ atoms/cm^3 when the oxygen concentration is $1.6x10^{18}$ atoms/cm3. Graef et al teaches the effect of doping the single crystal with nitrogen in terms of defect size distribution must also be considered in connection with the doping of the single crystal with oxygen and for the same nitrogen doping, the proportion of small defects increases as the oxygen doping decreases (col 3, ln 40-45), this is a teaching that the relationship between the oxygen and nitrogen doping concentration is a result effective variable. Therefore, it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Tamatsuka et al by optimizing the nitrogen and oxygen concentration to obtain same by conducting routine experimentation of result effective variables to minimize large defects. Furthermore, the selection of reaction parameters such as temperature and concentration is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Referring to claims 5, Tamatsuka et al does not teach the oxygen concentration is lowered corresponding to and in accordance with an increase in nitrogen concentration. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Tamatsuka et al by optimizing the oxygen concentration in relation to the nitrogen concentration

to obtain same by conducting routine experimentation of result effective variables because a connection with the oxygen concentration to the nitrogen concentration is known, note Graef et al (US 5,935,320)

Response to Arguments

5. Applicant's arguments with respect to claims 1-7 have been considered but are moot in view of the new ground(s) of rejection.

6. Applicant's arguments filed 4/30/2003 have been fully considered but they are not persuasive.

Applicant's argument that there is no suggestion in the art that optimization of the oxygen and nitrogen concentration would result in a better product has been considered but has not been found persuasive. Graef et al teaches for the same nitrogen doping, the proportion of small defects increases as the oxygen concentration decreases, note column 3, ln 40-45. This is a teaching that the nitrogen and oxygen concentration are result effective variables, which effect the defect size distribution in a single crystal. Also, Graef et al teaches doping the single crystal with nitrogen affects the defect size distribution, note column 3, lines 14-16. Furthermore, the selection of reaction parameters such as temperature and **concentration** is obvious (In re Aller 105 USPQ 233, 255 (CCPA 1955)).

Conclusion

7. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Krishna et al (US 5,571,373) teaches polishing a semiconductor wafer to reduce LPDs to about 7 per wafer (col 7, ln 30-67).

Kobayashi et al (US 6,245,311) teaches a heat treatment to obtain a silicon wafer having the number of LPDs not less than 0.12 micrometers of 20 COPs/8 inch wafer (col 11, ln 1-50).

Wilson et al (US 6,284,384) teaches a correlation between atoms/cm3 of oxygen to ppm, where $9x10^{17}$ atoms/cm3 is equivalent to 18 ppm (col 8, ln 60-67 and col 9, ln 1-15) and a wafer with defects of 0.12 micrometers is less than $0.5/cm^2$ (col 16).

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
July 1, 2003

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